

35.C15325

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:)
KOH ISHIZUKA) : Examiner: Unassigned
Application No.: Unassigned) : Group Art Unit: Unassigned
Filed: Concurrently Herewith) :
For: DISPLACEMENT DETECTION) :
APPARATUS, AND MAGNETIC) :
RECORDING APPARATUS AND) :
ENCODER USING THE) :
DISPLACEMENT DETECTION) :
APPARATUS) : April 24, 2001

Commissioner For Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Sir:

Prior to examination on the merits, please enter
the following amendments to the above-identified application.

IN THE CLAIMS:

Please amend Claims 8 to 15, and add new Claims 16
to 20 to read as follows. A marked-up copy of Claims 8 to
15, showing the changes made thereto, is attached.

8. (Amended) An apparatus according to claim 1, wherein said light beam splitting optical system is a crystal optical element.

9. (Amended) An apparatus according to claim 1, wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference.

10. (Amended) A magnetic recording apparatus comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions on a surface of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a slit-shaped marking or a three-dimensional marking is formed on the surface of the relatively moving object to generate a reflectance difference;

a head arm having the marking or reflectance boundary portion formed on an upper surface;

a rotary positioner having said displacement detection apparatus on a rotary arm; and

a head arm drive motor control unit for controlling a current of a head arm drive motor of a hard disk drive to synchronize a motion of said rotary positioner with a motion of said head arm so that an output from said displacement detection apparatus becomes constant as a position of said rotary positioner varies.

11. (Amended) A rotary encoder comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions on a surface of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a slit-shaped marking or a three-dimensional marking is formed on the surface of the relatively moving object to generate a reflectance difference;

wherein the slit-shaped marking or reflectance boundary portion is formed on a rotary disk surface; and

said displacement detection apparatus is provided on a fixed object side to receive the plurality of reflected light beams from the marking or reflectance boundary portion on a moving scale and to detect a scale origin from a

difference signal between the plurality of light receiving signals.

12. (Amended) A linear encoder comprising:

a displacement detection apparatus of comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions on a surface of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a slit-shaped marking or a three-dimensional marking is formed on the surface of the relatively moving object to generate a reflectance difference;

wherein the slit-shaped marking or reflectance boundary portion is formed on a linear encoder scale surface, and

said displacement detection apparatus is provided on a moving object side to receive the plurality of reflected light beams from the marking or reflectance boundary portion on the linear encoder scale and to detect a scale origin from a difference signal between the plurality of light receiving signals.

13. (Amended) A magnetic recording apparatus comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions on a surface of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting

light receiving signals of the respective light beams;
and

a comparator for comparing light receiving
signal levels of the respective light beams to detect a
relative displacement of the relatively moving object,

wherein a boundary portion is formed on the
surface of the relatively moving object to generate a
reflectance difference;

a head arm having the marking or reflectance
boundary portion formed on an upper surface;

a rotary positioner having said displacement
detection apparatus on a rotary arm; and

a head arm drive motor control unit for controlling
a current of a head arm drive motor of a hard disk drive to
synchronize a motion of said rotary positioner with a motion
of said head arm so that an output from said displacement
detection apparatus becomes constant as a position of said
rotary positioner varies.

14. (Amended) A rotary encoder comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for
converting a linearly polarized light beam emitted from

a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions on a surface of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference;

wherein the slit-shaped marking or reflectance boundary portion is formed on a rotary disk surface, and

said displacement detection apparatus is provided on a fixed object side to receive the plurality of reflected light beams from the marking or reflectance boundary portion on a moving scale and to detect a scale origin from a difference signal between the plurality of light receiving signals.

15. (Amended) A linear encoder comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of

polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions on a surface of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference;

wherein the slit-shaped marking or reflectance boundary portion is formed on a linear encoder scale surface, and

said displacement detection apparatus is provided on a moving object side to receive the plurality of reflected light beams from the marking or reflectance boundary portion on the linear encoder scale and to detect a scale origin from a difference signal between the plurality of light receiving signals.

--16. (New) An apparatus according to claim 7, wherein said light beam splitting optical system is crystal optical element.

17. (New) An apparatus according to claim 7, wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference.

18. (New) A magnetic recording apparatus comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object

with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions near an end portion of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a light receiving signal comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference;

a head arm having the marking or reflectance boundary portion formed on an upper surface;

a rotary positioner having said displacement detection apparatus on a rotary arm; and

a head arm drive motor control unit for controlling a current of a head arm drive motor of a hard disk drive to synchronize a motion of said rotary positioner with a motion of said head arm so that an output from said displacement detection apparatus becomes constant as a position of said rotary positioner varies.

19. (New) A rotary encoder comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from

said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions near an end portion of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a light receiving signal comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference;

wherein the slit-shaped marking or reflectance boundary portion is formed on a rotary disk surface, and

said displacement detection apparatus is provided on a fixed object side to receive the plurality of reflected light beams from the marking or reflectance boundary portion on a moving scale and to detect a scale origin from a difference signal between the plurality of light receiving signals.

20. (New) A linear encoder comprising:

a displacement detection apparatus comprising:

a light beam illuminating system for converting a linearly polarized light beam emitted from a light emitting element into a substantially parallel light beam and irradiating a relatively moving object with the light beam through a light beam splitting optical system, said light beam splitting optical system splitting the single parallel light beam emerging from said light beam illuminating system into a plurality of polarized light beams whose polarized states are different from each other;

a focusing optical system for focusing the plurality of split light beams to different positions near an end portion of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization; a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams; and

a light receiving signal comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference;

wherein the slit-shaped marking or reflectance boundary portion is formed on a linear encoder scale surface, and

said displacement detection apparatus is provided on a moving object side to receive the plurality of reflected

light beams from the marking or reflectance boundary portion on the linear encoder scale and to detect a scale origin from a difference signal between the plurality of light receiving signals.--

REMARKS

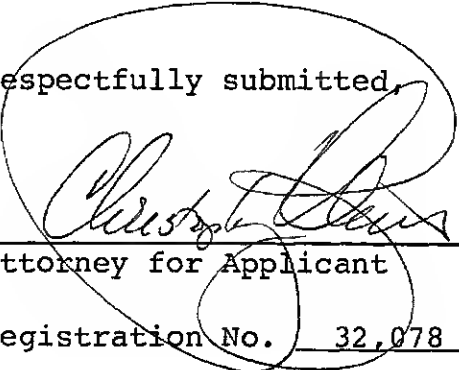
The present application is being filed concurrently herewith.

The claims pending in the present application are Claims 1 to 20, the independent claims being Claims 1, 7, 10 to 15 and 18 to 20. Claims 8 to 15 have been amended herein and Claims 16 to 20 have been added to improve the form of the claims under U.S. patent practice. No new matter has been added.

Applicant submits that the present application is in allowable form. Favorable consideration of the application and early passage to issue respectfully are requested.

Applicant's undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our below listed address.

Respectfully submitted,



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VERSION WITH MARKS TO SHOW CHANGES MADE TO CLAIMS

8. (Amended) An apparatus according to claim 1 [or 7], wherein said light beam splitting optical system is a crystal optical element.

9. (Amended) An apparatus according to claim 1 [or 7], wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference.

10. (Amended) A magnetic recording apparatus [using said] comprising:

a displacement detection apparatus [of claim 4,]
comprising:

a light beam illuminating system for
converting a linearly polarized light beam emitted from
a light emitting element into a substantially parallel
light beam and irradiating a relatively moving object
with the light beam through a light beam splitting
optical system, said light beam splitting optical system
splitting the single parallel light beam emerging from

said light beam illuminating system into a plurality of
polarized light beams whose polarized states are
different from each other;

a focusing optical system for focusing the
plurality of split light beams to different positions on
a surface of the relatively moving object;

a polarizing prism for splitting reflected
light beams from the relatively moving object on the
basis of a difference between the plurality of
directions of polarization;

a plurality of light receiving optical systems
for individually detecting the different polarized light
beams split by said polarizing prism and outputting
light receiving signals of the respective light beams;
and

a comparator for comparing light receiving
signal levels of the respective light beams to detect a
relative displacement of the relatively moving object,

wherein a slit-shaped marking or a
three-dimensional marking is formed on the surface of

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the relatively moving object to generate a reflectance
difference;

a head arm having the marking or reflectance
boundary portion formed on an upper surface;

a rotary positioner having said displacement
detection apparatus on a rotary arm; and

a head arm drive motor control unit for controlling
a current of a head arm drive motor of a hard disk drive to
synchronize a motion of said rotary positioner with a motion
of said head arm so that an output from said displacement
detection apparatus becomes constant as a position of said
rotary positioner varies.

11. (Amended) A rotary encoder [using said]
comprising:

a displacement detection apparatus [of claim 4,]
comprising:

a light beam illuminating system for
converting a linearly polarized light beam emitted from
a light emitting element into a substantially parallel

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light beam and irradiating a relatively moving object
with the light beam through a light beam splitting
optical system, said light beam splitting optical system
splitting the single parallel light beam emerging from
said light beam illuminating system into a plurality of
polarized light beams whose polarized states are
different from each other;

a focusing optical system for focusing the
plurality of split light beams to different positions on
a surface of the relatively moving object;

a polarizing prism for splitting reflected
light beams from the relatively moving object on the
basis of a difference between the plurality of
directions of polarization;

a plurality of light receiving optical systems
for individually detecting the different polarized light
beams split by said polarizing prism and outputting
light receiving signals of the respective light beams;
and

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a comparator for comparing light receiving
signal levels of the respective light beams to detect a
relative displacement of the relatively moving object,
wherein a slit-shaped marking or a
three-dimensional marking is formed on the surface of
the relatively moving object to generate a reflectance
difference;

wherein the slit-shaped marking or reflectance
boundary portion is formed on a rotary disk surface; and

said displacement detection apparatus is provided
on a fixed object side to receive the plurality of reflected
light beams from the marking or reflectance boundary portion
on a moving scale and to detect a scale origin from a
difference signal between the plurality of light receiving
signals.

12. (Amended) A linear encoder [using said]
comprising:

a displacement detection apparatus of [claim 4,]
comprising:

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a light beam illuminating system for
converting a linearly polarized light beam emitted from
a light emitting element into a substantially parallel
light beam and irradiating a relatively moving object
with the light beam through a light beam splitting
optical system, said light beam splitting optical system
splitting the single parallel light beam emerging from
said light beam illuminating system into a plurality of
polarized light beams whose polarized states are
different from each other;

a focusing optical system for focusing the
plurality of split light beams to different positions on
a surface of the relatively moving object;

a polarizing prism for splitting reflected
light beams from the relatively moving object on the
basis of a difference between the plurality of
directions of polarization;

a plurality of light receiving optical systems
for individually detecting the different polarized light
beams split by said polarizing prism and outputting

light receiving signals of the respective light beams;

and

a comparator for comparing light receiving
signal levels of the respective light beams to detect a
relative displacement of the relatively moving object,

wherein a slit-shaped marking or a
three-dimensional marking is formed on the surface of
the relatively moving object to generate a reflectance
difference;

wherein the slit-shaped marking or reflectance
boundary portion is formed on a linear encoder scale
surface[;] and

said displacement detection apparatus is provided
on a moving object side to receive the plurality of reflected
light beams from the marking or reflectance boundary portion
on the linear encoder scale and to detect a scale origin from
a difference signal between the plurality of light receiving
signals.

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13. (Amended) A magnetic recording apparatus
[using said] comprising:

a displacement detection apparatus [of claim 9,]
comprising:

a light beam illuminating system for
converting a linearly polarized light beam emitted from
a light emitting element into a substantially parallel
light beam and irradiating a relatively moving object
with the light beam through a light beam splitting
optical system, said light beam splitting optical system
splitting the single parallel light beam emerging from
said light beam illuminating system into a plurality of
polarized light beams whose polarized states are
different from each other;

a focusing optical system for focusing the
plurality of split light beams to different positions on
a surface of the relatively moving object;

a polarizing prism for splitting reflected
light beams from the relatively moving object on the

basis of a difference between the plurality of
directions of polarization;

a plurality of light receiving optical systems
for individually detecting the different polarized light
beams split by said polarizing prism and outputting
light receiving signals of the respective light beams;
and

a comparator for comparing light receiving
signal levels of the respective light beams to detect a
relative displacement of the relatively moving object,

wherein a boundary portion is formed on the
surface of the relatively moving object to generate a
reflectance difference;

a head arm having the marking or reflectance
boundary portion formed on an upper surface;

a rotary positioner having said displacement
detection apparatus on a rotary arm; and

a head arm drive motor control unit for controlling
a current of a head arm drive motor of a hard disk drive to
synchronize a motion of said rotary positioner with a motion

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of said head arm so that an output from said displacement detection apparatus becomes constant as a position of said rotary positioner varies.

14. (Amended) A rotary encoder [using said]

comprising:

a displacement detection apparatus [of claim 9,]

comprising:

a light beam illuminating system for
converting a linearly polarized light beam emitted from
a light emitting element into a substantially parallel
light beam and irradiating a relatively moving object
with the light beam through a light beam splitting
optical system, said light beam splitting optical system
splitting the single parallel light beam emerging from
said light beam illuminating system into a plurality of
polarized light beams whose polarized states are
different from each other;

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a focusing optical system for focusing the plurality of split light beams to different positions on a surface of the relatively moving object;

a polarizing prism for splitting reflected light beams from the relatively moving object on the basis of a difference between the plurality of directions of polarization;

a plurality of light receiving optical systems for individually detecting the different polarized light beams split by said polarizing prism and outputting light receiving signals of the respective light beams;
and

a comparator for comparing light receiving signal levels of the respective light beams to detect a relative displacement of the relatively moving object,

wherein a boundary portion is formed on the surface of the relatively moving object to generate a reflectance difference;

wherein the slit-shaped marking or reflectance boundary portion is formed on a rotary disk surface, [;] and

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said displacement detection apparatus is provided
on a fixed object side to receive the plurality of reflected
light beams from the marking or reflectance boundary portion
on a moving scale and to detect a scale origin from a
difference signal between the plurality of light receiving
signals.

15. (Amended) A linear encoder [using said]
comprising:

a displacement detection apparatus [of claim 9,]
comprising:

a light beam illuminating system for
converting a linearly polarized light beam emitted from
a light emitting element into a substantially parallel
light beam and irradiating a relatively moving object
with the light beam through a light beam splitting
optical system, said light beam splitting optical system
splitting the single parallel light beam emerging from
said light beam illuminating system into a plurality of

polarized light beams whose polarized states are
different from each other;

a focusing optical system for focusing the
plurality of split light beams to different positions on
a surface of the relatively moving object;

a polarizing prism for splitting reflected
light beams from the relatively moving object on the
basis of a difference between the plurality of
directions of polarization;

a plurality of light receiving optical systems
for individually detecting the different polarized light
beams split by said polarizing prism and outputting
light receiving signals of the respective light beams;
and

a comparator for comparing light receiving
signal levels of the respective light beams to detect a
relative displacement of the relatively moving object,

wherein a boundary portion is formed on the
surface of the relatively moving object to generate a
reflectance difference;

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wherein the slit-shaped marking or reflectance
boundary portion is formed on a linear encoder scale
surface_L[;] and

said displacement detection apparatus is provided
on a moving object side to receive the plurality of reflected
light beams from the marking or reflectance boundary portion
on the linear encoder scale and to detect a scale origin from
a difference signal between the plurality of light receiving
signals.